

"We were making the future," he said, "and hardly any of us troubled to think what future we were making. And here it is!"

H.G. Wells, *The Sleeper Awakes* (1910)

## ECOLOGY AND WILDLIFE

# Climate Change and the Arctic Diet

Each spring, female polar bears and their cubs emerge from hibernation after months without food, and their survival depends on having good sea ice for hunting seals, their almost exclusive food. Also in spring, the Arctic sea ice begins to melt and break apart. Over the past 25 years, the timing of this melting has become less predictable as a consequence of warming in the Arctic, varying by more than a month. Researchers in Canada now report the first evidence that changes in the timing of the annual sea ice breakup have contributed to a dietary shift for polar bears from western Hudson Bay in the Canadian sub-Arctic. This shift may be accelerating the bears' bioaccumulation of some classes of persistent contaminants, and people who consume these animals as part of a traditional subsistence diet could face greater exposure to contaminants that are passed up the food chain.

Research scientists Robert Letcher and Melissa McKinney of the National Wildlife Research Centre at Carleton University led the study, in collaboration with Elizabeth Peacock, a polar bear biologist for the Government of Nunavut. As reported in the 15 June 2009 issue of *Environmental Science & Technology*, the team measured levels of pollutants including polychlorinated biphenyls (PCBs) and

polybrominated diphenyl ether (PBDE) flame retardants in western Hudson Bay polar bears between 1991 and 2007. They also measured fatty acids and carbon isotopes in the bears' fatty tissues to determine what types of seals the bears were eating. Ice-associated seals, which eat from the sea floor, leave a different carbon signature than open-water seals, which eat higher on the food chain and thus accumulate higher contaminant levels.

In the years the sea ice broke up earlier, polar bears ate more open-water species such as harbor and harp seals instead of ice-associated species such as bearded seals, perhaps because the former are more abundant in light ice conditions. As evidenced by carbon isotope analyses, the timing of spring ice breakup explained 84% of the variation in the polar bears' diet from year to year.

The researchers say the effects of the bears' dietary shift are large enough in the case of PCBs to offset an apparent trend of decreasing concentrations in western Hudson Bay bears over the study period and to significantly accelerate an increasing trend in PBDEs. Letcher notes, however, that levels of PCBs, PBDEs, and other pollutants such as perfluorooctane sulfonate (PFOS) vary considerably among other northern bear populations and that time trend data are lacking in many regions. Climate change could also increase long-distance transport of pollutants to the Arctic by changing atmospheric circulation and hydrology, according

to *Climate Change 2007: Impacts, Adaptation and Vulnerability*, the latest Intergovernmental Panel on Climate Change report.

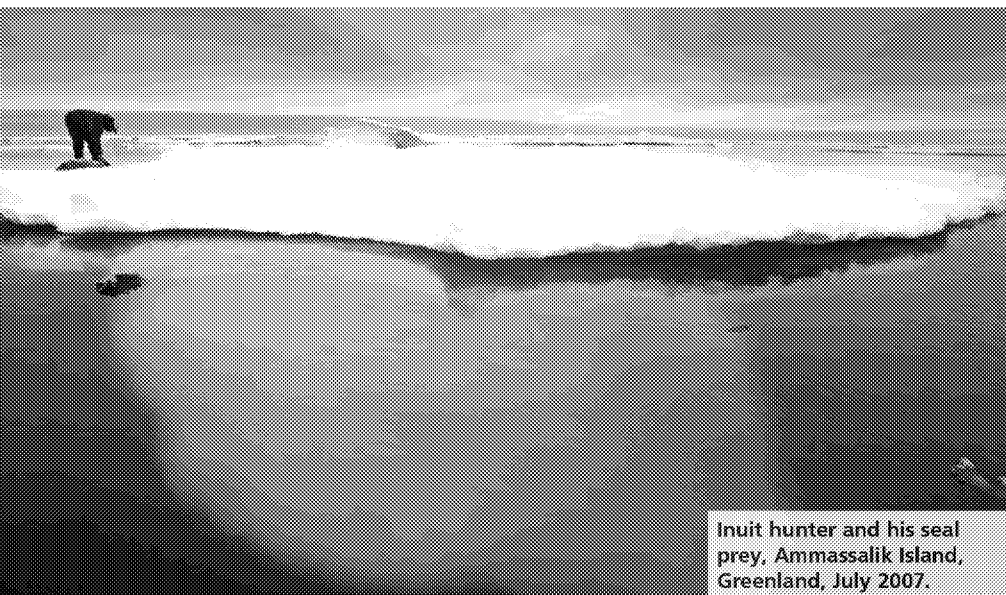
The new research raises questions for Inuit populations that consume polar bears and other animals high on the food chain. "[The study] should be replicated because it suggests that changing polar bear diets could increase human exposure to persistent organic pollutants in Native Americans and others who consume polar bears as part of a traditional diet," says epidemiologist Kristie Ebi, a Virginia-based independent consultant on health issues related to climate change. Ebi was a lead author of the human health chapter in *Climate Change 2007*, which concluded that the traditional diet of Arctic residents is likely to be adversely affected by climate change.

The Inuit diet, a varying mixture of fish and game, is rich in omega-3 fatty acids and has been linked to health benefits such as reduced heart disease, obesity, and diabetes. However, these foods are also the primary source of exposure to environmental contaminants for far-northern human populations. Rune Dietz, an environmental biologist at the University of Aarhus, Denmark, who studies contaminants both in polar bears and in human subsistence diets, says, "If we see [contaminant] increases in wildlife, most likely this will be related to hunters as well, because they have access to the same seals as polar bears."

Shifting levels of other contaminants also are being observed. In ice-associated ringed seals, for example, changes in sea ice conditions increase mercury levels by shifting the seals' food supply toward cod, which is the most contaminated of their food sources, according to a study led by Gary Stern and published in the 15 May 2009 issue of *Environmental Science & Technology*.

Contaminant levels are already of concern for the Inuit and are monitored by the Arctic Monitoring and Assessment Programme, which informs Arctic governments about pollution trends and sources. Russel Shearer, international chairman of the program, says, "The risk from exposure to contaminants from traditional foods needs to be balanced in the greater public health context, especially for women of childbearing age."

Erika Engelhaupt is a freelance writer in Washington, DC, and has written for *Environmental Science & Technology*, *The Philadelphia Inquirer*, and other publications.



Inuit hunter and his seal prey, Ammassalik Island, Greenland, July 2007.

AP Photo/John McCormico

## CLIMATE CHANGE

## Challenges of Predicting Wildfire Activity

An increase in wildfire activity is one of several effects predicted to arise in some areas as a result of climate change. Two new studies suggest, however, that wildfires are more complex—and their future prevalence less predictable—than is commonly assumed. “We hear a lot that the entire planet will be burning in the future, but there’s not good evidence to back this up,” says Max Moritz, co-director of the Center for Fire Research and Outreach at the University of California, Berkeley.

Moritz and his colleagues designed a new pyrogeography model to predict wildfire activity out to 2099. Their novel “ecosystem niche” model treats fire as an organism within an ecosystem and characterizes its “habitat requirements,” with flammable vegetation serving as the consumable resource and fire-conductive weather patterns and climate—such as hot, dry winds and temperatures—constituting the environmental conditions. “Our results challenge the simplistic view that climate change will cause more fires everywhere,” Moritz says.

The model, described in the 8 April 2009 edition of *PLoS ONE*, predicted that wildfires could increase in the western United States and Tibetan plateau but decrease in northeast China and central Africa. The leading single predictor of wildfires was the amount of vegetation available to burn, followed by hot, dry conditions, yet neither alone ensures fire. For instance, rainforests contain dense vegetation, but high moisture levels constrain fire activity, which could explain why most tropical evergreen forests of the central Amazon and the Congo have stayed relatively fire-free even during anomalously dry periods. Deserts, on the other hand, are hot and dry but lack sufficient vegetation to support fires.

Vegetation also proved a key ingredient in ancient wildfires that burned in Alaska’s Brooks Range some 15,000 years ago, suggest Philip Higuera and colleagues in the May 2009 issue of *Ecological Monographs*.



The forest burns along the Sheenjek River near Fort Yukon, Alaska, June 2005.

They examined sediment cores collected at various depths from lake bottoms to assess changes in pollen and other plant materials that grew during certain periods. They used carbon-14 dating to determine the age of charcoal found in the cores—an indicator that a fire had occurred.

Higuera’s team discovered that the impact of climate change on fire occurrence was often mediated by changes in vegetation, sometimes in ways that seemed counterintuitive. The climate transitioned from cool and dry to warm and dry about 10,500 years ago, yet fire frequency declined sharply over the course of about 1,000 years. This was likely due to a climate-induced shift in vegetation from flammable shrubs to more fire-resistant deciduous trees. In contrast, the team observed an increase in fire frequency about 5,000 years ago despite the onset of cooler temperatures and higher moisture levels. The rise of dense, highly flammable coniferous forests probably fueled these fires.

The importance of vegetation in facilitating or retarding fire is well known by fire scientists, says Higuera, an ecologic research fellow in the Department of Earth Sciences at Montana State University, Bozeman. What these two new studies offer, he says, are the large spatial and temporal scales at which they were conducted. “At these scales, the influence of vegetation is more apparent than it is at the smaller scales on which earlier studies have focused,” he explains, “and we can make statements about the impacts of climate change on fire regimes over large spatial and temporal scales.”

Higuera’s findings from ancient times may apply to today’s changing climate. Several studies have predicted that in Alaska, where temperatures are climbing faster than at lower latitudes, conifers will burn and be replaced by deciduous trees such as aspen

and birch, typically the first species to recolonize an area after a fire. “Our study suggests there will be a decrease in the probability of fire with a transition to [less flammable] deciduous forests,” says Higuera. He adds that such transitions have happened over multiple centuries in the past, but it is possible they could

happen more quickly in the future because of human impact.

“The patterns found by Higuera are striking, but it has yet to be shown that similar patterns are seen in places other than central Alaska,” says University of Oregon geography professor Dan Gavin, who with Higuera coauthored a report in the October 2008 issue of *Nature Geoscience* on global biomass burning over the past two millennia. In many other regions, paleoecologic studies have shown that fires increased as the climate became warmer and drier, and decreased as it became cooler and wetter.

The interactions between climate, geography, ecosystems, and wildfires have major implications for public health. Beyond the obvious air quality issues associated with smoke, a study by Teresa C. Wegesser and colleagues in the June 2009 issue of *EHP* indicated that particulate matter produced during California’s 2008 wildfire season was more toxic to the lungs than particles collected from ambient air.

Wildfires can also have indirect health consequences. For instance, in work published online 28 May 2009 ahead of print in *Zoonoses and Public Health*, veterinary biologist Hume E. Field of the Australian Biosecurity Cooperative Research Centre for Emerging Infectious Diseases noted that recent deforestation and fires in Australia and Asia may have disrupted habitat for fruit bats (genus *Pteropus*). Field and others hypothesize that fire-related deforestation and other ecologic forces have driven fruit bats to seek food closer to towns, where they spread fatal Hendra and Nipah viruses to farm animals and people. “These more subtle health effects of fire are hardly looked at,” says Moritz.

Montana-based Carol Potera has written for *EHP* since 1996. She also writes for *Microbe*, *Genetic Engineering News*, and the *American Journal of Nursing*.

## NATURAL DISASTERS

## Arsenic Spike from Ike

A study of the sediment left behind by flooding from Hurricane Ike in September 2008 shows that although levels of most of the toxic compounds assayed are low, some concerns remain about elevated arsenic levels. The larger impact, however, may come from the cooperation between scientists and community members, whose combined effort has yielded valuable insights as coastal communities gear up for the 2009 hurricane season.

To determine exactly what Hurricane Ike delivered, researchers from the University of Texas Medical Branch (UTMB) in Galveston joined local volunteers from community organizations to collect sediment samples. The samples, collected from hard surfaces to distinguish flood-borne sediment from pre-existing soil, were analyzed at a nearby laboratory. The results showed mostly "good news," the team reported in the February 2009 white paper "Analysis for Toxic Materials in Sediments from Hurricane Ike in Galveston, TX." The sediment did not contain sufficient levels of most pollutants measured—such as polychlorinated biphenyls, dioxins, and petroleum products—to require remediation.

However, several sites had elevated levels of some metals, including arsenic at amounts up to 48 times the U.S. Environmental Protection Agency's residential screening level, although below the level that legally requires cleanup. Moreover, the highest arsenic levels were found in a particularly poor neighborhood. "Without adequate information and self-protection," the team wrote, "this community will likely suffer a heavier exposure burden, and may be most vulnerable to the effects of that burden."

The report is not comprehensive, the team acknowledges; the nine samples collected cannot show the complete picture, and the analytical tests were basic. However, with the resources at hand (and a \$7,500 budget), the minimal data set is enough to support the team's basic conclusions: floodwaters tend to stir up what's already there, while sometimes adding more contaminants from elsewhere, depending on where the floodwaters originated.

Some likely sources of the arsenic in Galveston include now-defunct industrial sites, says project co-investigator Jonathan Ward. An old tin smelter across Galveston Bay, for example, once dumped its waste into a channel that directly flowed into the estuary, Ward says. Co-investigator Sharon Petronella says the UTMB team wants to map out such "legacy" contaminants in a geographic information system to serve as a "predecessor for a risk assessment working backwards."

Howard Mielke, a research professor at Tulane University who has documented lead-laden soils of New Orleans and other cities, notes that such a historical record would have been useful in assessing Hurricane Ike flood deposits. With 22% of the Galveston samples containing lead levels over 200 ppm, Mielke says the post-Ike lead content seems relatively high. He adds, "Because of their extraordinary vulnerability, no child should be playing in soil with a lead content above 100 ppm."

The sediment monitoring project is part of UTMB's LEAST Lead Initiative, which seeks to reduce lead poisoning in Galveston in cooperation with county and state agencies and with St. Vincent's House, a nonprofit social service agency. The impetus for the monitoring project came from St. Vincent's executive director Michael Jackson, who rallied support at a meeting in the gutted bottom story of the agency a few weeks after Ike struck. Petronella says, "If you don't have a community voice at the table, you are not going to understand what the community needs." Community involvement such as having residents tell their neighbors how to protect babies from hand-to-mouth exposure had been important to LEAST Lead's efforts prior to Hurricane Ike and proved equally effective with regard to exposure to flood debris and sediments.

Researchers outside the project agree that the collaborative nature of the work is a positive highlight of the report. Research geochemist Geoff Plumlee of the U.S. Geological Survey, who assessed New Orleans flood deposits after Hurricane Katrina in 2005, says the report "actually got me thinking about things we could do at the local grass-roots level, because that's clearly where the impacts are."

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## The Beat

by Erin E. Dooley

### FDA to Revisit BPA Decision

In June 2009, FDA Commissioner Margaret Hamburg announced the agency is revisiting its August 2008 decision that levels of bisphenol A (BPA) found in plastic bottles and other food containers are safe. Acting FDA Chief Scientist Jesse Goodman will lead the reevaluation, which should be completed by early fall 2009. Amidst the growing debate over the safety of BPA, several U.S. states and municipalities have enacted restrictions on the chemical, and some manufacturers and retailers have voluntarily removed the chemical from their products and shelves.

### Cutting Marine Litter

Marine litter poses complex environmental, economic, health, and aesthetic problems in water bodies around the world. In the April 2009 report *Marine Litter: A Global Challenge*, UNEP outlines methods to reduce this waste

stream, such as the requirement that food vendors in national parks use biodegradable plates and cups, incentives for fishermen to remove debris from the ocean when they spot it, and taxes on plastic grocery bags. In Ireland such a tax led to a 90% reduced use of these items. The report also called for investment in waste management infrastructure and education and outreach to exchange technical information and generate a sense of environmental stewardship.

Marine litter affects all the oceans of the world.



### Smoking and Gum Disease: More to the Story

Smokers are more prone to chronic gum disease caused by the bacterium *Porphyromonas gingivalis* than nonsmokers and can have more severe symptoms and poorer response to conventional treatments. In the May 2009 issue of *Environmental Microbiology*, scientists show that exposure to cigarette smoke alters *P. gingivalis* genes associated with detoxification, oxidative stress mechanisms, and DNA repair. The resulting changes in the expression of proteins in cell membranes can affect how the smoker's immune system reacts to the pathogen. This finding may help researchers find better treatments for *P. gingivalis* infections.

### Cellular Switch for Allergies, Asthma Discovered

Kelly Speiran et al. report in the May 2009 issue of the *Journal of Leukocyte Biology* the discovery of a mechanism that turns allergies and asthma on and off. When cytokines IL-4 and IL-10, which initiate immune responses, were

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## PESTICIDES

## Double Exposure Heightens Parkinson Disease Risk

Approximately 1 million U.S. residents and more than 4 million people worldwide have been diagnosed with Parkinson disease (PD), a chronic motor system disorder that usually strikes people over age 60 and triples in those over 85. Epidemiologic studies have consistently found that pesticide exposures heighten the risk of developing PD, a connection further strengthened by rodent studies. However, most studies to date have relied on self-reports and recall of chemical usage, bias-prone mechanisms that make it hard to accurately estimate exposure. A team of researchers led by epidemiologist Beate Ritz of the University of California, Los Angeles (UCLA) may have overcome that hurdle with a new exposure model.

Their study, published 15 April 2009 in the *American Journal of Epidemiology*, suggests that two commonly used pesticides increase PD risk, especially in people exposed at an early age. The UCLA team focused on the combined effects of the herbicide paraquat and the fungicide maneb. When used either alone or in combination with maneb, paraquat had been found in several rodent studies to cause neuronal degeneration and symptoms like those seen in PD patients.

The researchers compared pesticide exposures for 368 California residents diagnosed with PD between January 1998 and January 2007 and 341 randomly selected local controls. The subjects lived in agricultural regions in Fresno, Tulare, and Kern counties; most were white, over age 60, and had no family history of PD.

Exposure estimates came from maps of land use and from a geographic information system incorporating pesticide application records from the California Department of Pesticide Regulation. "We found a way to assess historic pesticide

exposure without relying on subject recall," says first author Sadie Costello, now a postdoctoral research fellow in the Department of Environmental Health Sciences at the University of California, Berkeley, School of Public Health. Both data sets were linked to subjects' current and former addresses within the three-county region.

The researchers examined subjects' exposure from 1974 to 1989, from 1990 to 1999, and for the entire time period. Subjects were considered exposed if one or both pesticides were applied within 500 m of their homes while they lived there. Exposure to both pesticides during the 25-year period was associated with a 75% increase in PD risk.

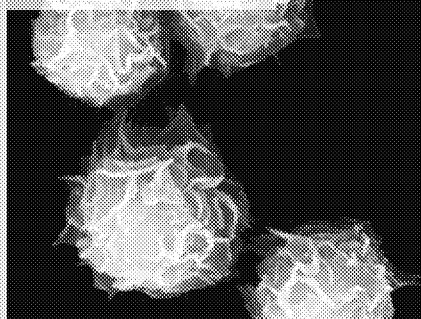
Yet associations varied depending on subjects' age and the timing of exposure. In participants aged 60 or younger at diagnosis (cases) or interview (controls), estimated relative risks of PD with exposure to one or both pesticides were similar regardless of whether exposure occurred between 1974 and 1989 or 1990 and 1999. However, among participants over 60 years of age, associations with PD appeared to be limited to pesticide exposures during the earlier (1974–1989) time period.

Freya Kamel, an NIEHS epidemiologist who has studied the suspected link between pesticides and PD, cautions against assuming that age at exposure can explain the different PD risks. "I don't think I'd want to speculate until I saw it in more studies," she says. She notes that the basic precept that developing brains are more vulnerable to neurotoxins usually applies to prenatal and infant exposures, not to exposures in childhood or young adulthood.

Kamel predicts future studies will move toward determining how genetics affects individuals' susceptibility to environmental toxicants. "Assessing gene–pesticide interactions is a goal of our research," Costello says. "We have a couple of papers on the topic coming out shortly."

Cynthia Washam writes for *EHP*, *Oncology Times*, and other science and medical publications from South Florida.

**Mast cells play a central role in inflammatory and allergic reactions.**



added to developing mast cells, those cells died, leading the researchers to conclude that not only are the cytokines the "on switch" for immune response, they are also the "off switch" that stops overproliferation of mast cells, which can cause allergies and asthma. The authors wrote, "Our data support the theory that IL-4 and IL-10 function as endogenous regulators of mast cell development and are produced by immature mast cells during their ontogeny." The team

hopes their work will lead to new medications that treat the root causes of these diseases.

### Well Testing for Well Children

In May 2009 the American Academy of Pediatrics issued new guidelines, developed in conjunction with the NIEHS, recommending that private well owners test their drinking water at least once per year for contaminants such as nitrate, coliform bacteria, and metals including lead and arsenic. Well water should also be tested when a child is born or if the well sustains structural damage. Children can become dehydrated quickly if they develop diarrhea from drinking bacterially contaminated water, and nitrates can cause a potentially serious condition known as methemoglobinemia in infants. Private well water, which is used by 6% of households in the United States, is not subject to federal water regulations.

### Concrete's Carbon Footprint

The concrete industry is believed to contribute about 5% of global CO<sub>2</sub> emissions. Decades after it is laid, concrete—the world's most commonly used building material—reabsorbs small

amounts of CO<sub>2</sub> to form calcite. Data published by Liv Haselbach in the June 2009 *Journal of Environmental Engineering* suggest concrete may form other carbon-based compounds besides calcite and, in the process, may reabsorb more CO<sub>2</sub> than previously thought. A better understanding of the complexities of concrete's reabsorption processes may help scientists develop new ways to speed up CO<sub>2</sub> reabsorption in recycled concrete and pavement.

